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THE DEMINERALIZATION OF SALINE WATER WITH SOLAR ENERGY

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The demineralisation of saline water with solar energy

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1. The future of many less-developed areas of the world depends in part on the availability of fresh water. This term will here be used to indicate water containing less than 1000 p.p.m. of dissolved salts. There is however a very large number of different conditions and needs: for this reason the study of the ways for giving fresh water to arid zones requires many different approaches.

2. In order to satisfy the needs of an industrial area or of a large community it is necessary either to make hydraulic works and networks or, if only saline water is available, to use demineralization processes requiring cheap fuels or nuclear energy. This can be made in large plants and presently techniques are available which allow to foresee the future developments.

3. On the other side there is a large number of little communities or isolated country houses having available only water containing more than 1000 p.p.m. of salts and in this case the use of solar distillation may prove successful for obtaining little amounts of water for drinking or domestic uses. The problem of the manufacture of efficient and simple solar stills has been studied in many laboratories for at least ten years (1). It is now possible to summarize such results.

4. First of all it is necessary to clear that at the present the solar stills cannot be used in large plants, for producing ~~w~~ fresh water in amounts of the order of thousands cubic meters per day. In fact in the single-effect solar stills the water production in favourable conditions is of the order of 4 liters/(sq.meter)(day), with an yearly average of 1 cubic meter/sq.meter. In these conditions the production of 1 cubic meter of distilled water per day requires a collecting surface of about 250 sq.meters. If multiple-effect stills would be developed - at expenses of simplicity and cost - this figure might be reduced to 50 sq.meters per cubic meter per day.

5. So far but few attempts have been made to build large scale solar stills; one of these has been designed and built by Löf (2)(3)(4); the second is a project of a solar still with a production of about

1 thousand tons per day, now yet in the laboratory scale, developed in the University of Arizona at Tucson (5). On the contrary there is an immediate field of application for little solar stills for giving water to families or little communities in arid zones. The solar stills for these communities should be manufactured in place, using local materials, following the design lines which have been tested in the past years in various laboratories in the world. The dimensions of such stills may range between 1 and 100 sq.meters of collecting surface.

6. In the author's opinion the success of the solar stills depends largely on their simplicity in design and cheapness, also at expenses of the water yield. An increase of water yield does not pay if is obtained with sacrifice of simplicity, through introduction of auxiliary equipments or of more costly materials. In fact the great advantage of the solar stills is the minimum maintenance they required, derived by the fact that there is no movable part or mechanism. Also the life of the stills seems of secondary importance if the stills can be manufactured in place with local materials. In any way a minimum availability of mechanical shops and facilities and of building materials is necessary.

7. For the manufacture of single-effect solar stills essentially few elements are necessary. Such elements can be assembled in a large number of different ways (6) and can be made with a large number of different materials. The still must essentially contain:

(a) one cover, transparent to solar radiation and opaque to infrared radiation, which is generally used also as an heat exchanger and condensing surface: this condensing surface is surrounded by a little channel for the collection of the distilled water;

(b) one tray or pad exposed to the solar radiation and containing the saline water to be distilled: it must be blackened to increase the solar energy absorption;

(c) one insulation under the tray or pad, for reducing the heat losses; such insulation may also be given by a layer of still air.

Because of the large number of practical solutions which can be given to the assembling of a solar still, the development of such still must be considered, at the present, a technological, rather than a scientific, problem.

8. There is yet one area of scientific interest, namely the study of the thermodynamics of the solar distillation. At the writer's knowledge there are at least three different approaches to this treatment, one by Telkes (7)(8)(9), a second by Baum (10) and the third by workers at the Georgia Institute of Technology (11).

9. The scientific studies and the experimental work so far available have indicated the lines for the economic and efficient manufacture of solar stills and some designs are now available. The manufacture of solar stills and their field use depend on the cost and availability of materials, labor, shop facilities, etc. It seems reasonable to foresee that the manufacture near the

installation site will be preferred to the manufacture in industrialized area and the shipment to users.

10. The solar stills can be manufactured mainly following two ~~designs~~ designs.

(a) The type of solar stills shown in Fig. 1 can be assembled in units of about 1 or 2 sq.meters of collecting area, is very simple and requires a minimum of labor and facilities. This design has been tested in various forms by many laboratories (12)(13)(14)(15) and has been found satisfactory. In this Institute we are manufacturing such little units (Solar still model No. 8) in order to collect accurate data on the cost and the ~~life~~ life of the still.

(b) The concrete type of solar still, designed for being placed on the roof of the country houses as structural element of the house itself (Fig. 2). One experimental still of this design (Solar still model No. 5) was tested in this Institute years ago (1)(16). According to this design the saline water is pumped in the trays and the distilled water flows by gravity in a tank into the house. For the field application of this model it is necessary to solve some constructive problems. The water in the tray, in fact, reaches a temperature as high as 70-75°C and the concrete layer easily breaks and water losses occur; difficulties are also encountered in the blackening and insulation of the concrete layer of the tray. Probably it will be easier to manufacture structural ~~one~~ elements of molded black plastic material. Fig. 3 shows an example of the section of such elements. They might be placed on a layer of insulating material, on the roof of the building.

11. For the various parts of both types of solar stills various building materials can be used but attention must be directed to the most easily available, local and cheap materials, like iron ~~sh~~ sheets, glass, wood, black paints. Galvanic treatments for blackening the iron sheets must be preferred but they seem hardly applicable in the field. There are many interesting designs based on the use of plastic materials, with the advantage of rather low cost and ~~w~~ weight, but, in the writer's opinion, they require mechanical complications or auxiliary equipments which are too troublesome for an immediate field application. They probably will be successful after further developments and new inventions.

12. The success of solar stills depends in large part by the efforts in order to educate the users to their best use; the distilled water is unpleasant to drink and it is generally necessary to readjust its taste with salts and gases.

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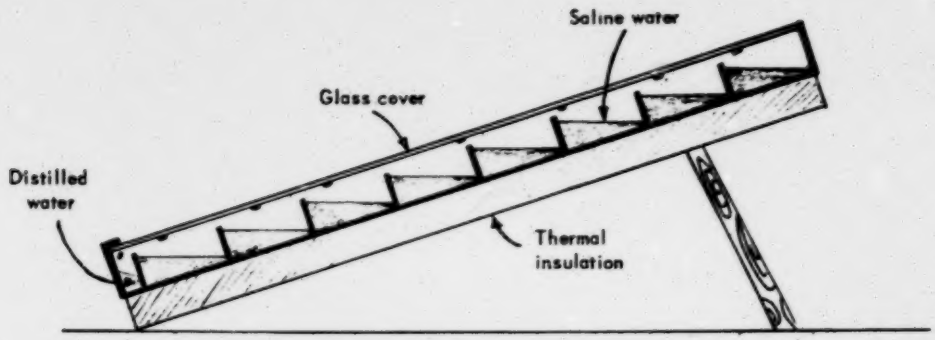

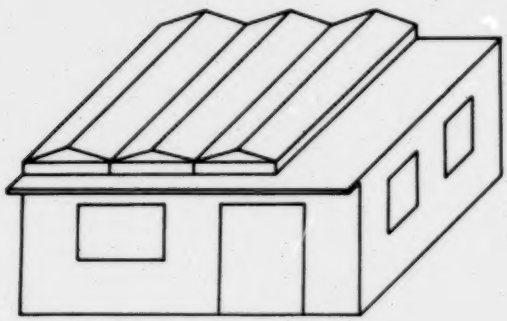

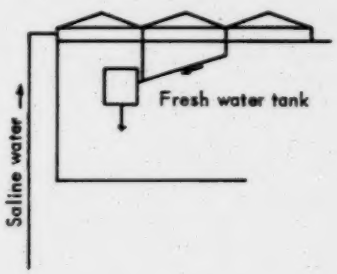

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